

Abstract: The importance of user authentication is a very important aspect especially when the number of users plus the size of the data to be checked against forgery has been increasing exponentially. Biometric Authentication can be done in many ways such as retina, voice, palm, or finger-print recognition. Along with those, the behavioral biometric verification can be used very effectively. A biometric signature is a behavioral biometric recognition that can be done by your actual handwriting signature on -say- a PDA using a digital pen. Biometric recognition systems have produced mostly for the reasons for Identification and Verification. Developing those systems for monitoring and providing access control is now a common practice in a variety of companies, banks, hospitals as well as in public organizations. We intend to develop a mobile application that provides signature verification and transaction management for documents that are hand-signed by clients. Since we deal with the biometric data of the users of the aforementioned organizations, surely the most important issue is security.



Overview

For a long time signature has always been associated with that of law requirement. The usage of a signature confirms the identity of every individual. It creates a legally binding contract or agreement between two or more parties. Biometrix is a mobile application for signing any document with users biometric signature. Principally, Biometrix will provide conformity for companies from all industries, banks, hospitals, government offices, and other organizations.

Biometrix is a mobile application for signing any document in an accustomed way with a state of the art level of security. Principally the application focuses on dynamic (online) signature recognition which will be assisted by artificial intelligence for obviating forgeries. Biometrix aims to solve another vital problem on our planet: tree consumption for paper. With start to using Biometrix by both public and private corporations, we may save billions of trees every year.

What are included Biometrix?



Mobile Application



Web Application



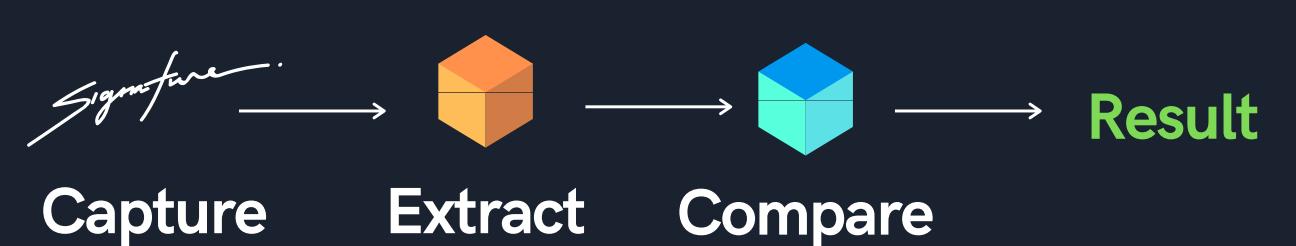
Data API

Features

- **SIGN DOCUMENT**
You can sing your documents and verify your signature.
- **TRANSACTION MANAGEMENT**
You can control all transactions in your system from your browser or device
- **GENERATE REPORT**
You can create a report includes detail of your transactions for satisfy your forensics concerns
- **TEXT EDITOR**
You can create documents to sign and edit using our style toolbar
- **USER MANAGEMENT**
You can manage both client and system administrators information

Biometric Signature

The most significant benefit of signature recognition is that it is highly resistant to impostors. After the user puts own signature on a mobile device, Biometrix captures dynamic pieces of information. This information consists of x-y coordinates, pressure, velocity, acceleration, time difference, pen tip force, azimuth, elevation angle of the pen and rotation about the pen axis.



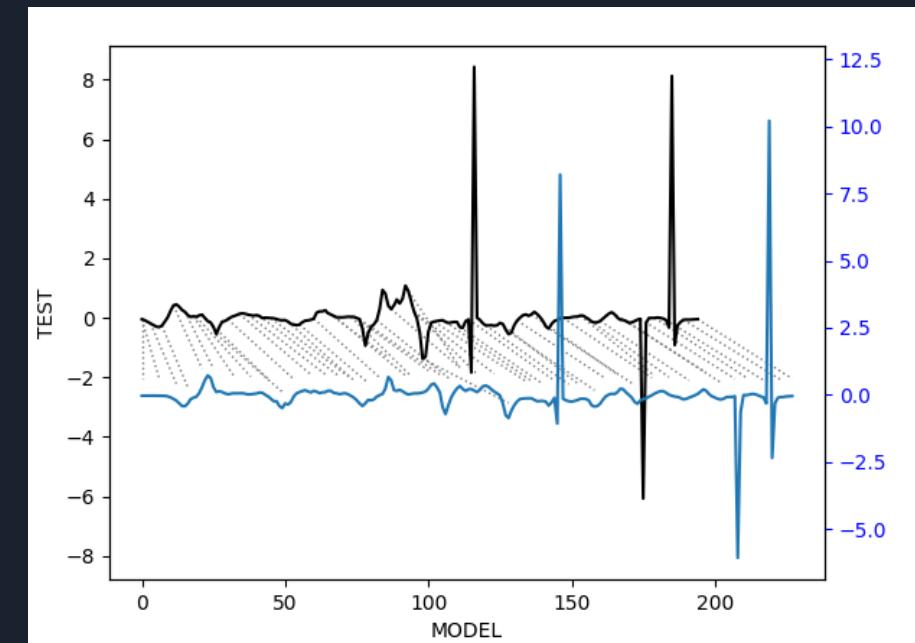
In the capturing phase, we normalized location of the signature and removed the jagged of signature. Before we start to capture a signature, the signer could start to sign any location of the surface thus we normalized all x and y locations for each point. The tablet device may have a low resolution. So smoothing signature is an important preprocessing operation before extracting local features. Since signature data already collected from mobile device, we have to extract local features. After extraction, we will have 20 features for each point using for signature recognition:

- The normalized x coordinate
- The normalized y coordinate
- The pressure
- The altitude angle
- The azimuth angle
- Speed in x direction
- Speed in y direction
- Acceleration in x direction
- Acceleration in y direction
- Absolute acceleration
- Tangential acceleration
- Press derivation
- Sine of the α
- Cos of the α
- The α angle between the absolute $\alpha(t)$ velocity vector and the x axis
- Derivation of α angle
- Sine of the $\alpha'(t)$
- Cos of the $\alpha'(t)$
- The angle between two adjacent line segments at each coordinate

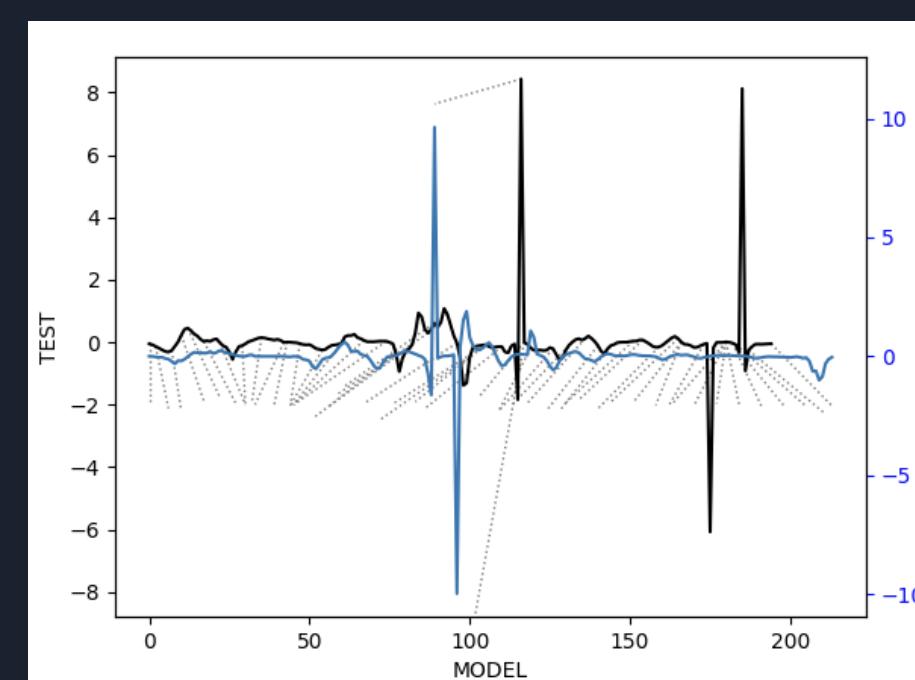
Dynamic Time Warping

The Dynamic Time warping algorithm is used to compare the similarity or distance between two time series with different length. It originates from the field of sound pattern recognition. Actually it can be used any temporal sequences of video, audio, graphics data or any data that can be turned into a linear sequence. Following figures demonstrates instance of two different test signature comparisons using with DTW.

Alignment for Genue Signature-Model



Alignment for Forgery Signature-Model



Blockchain

When a new user model created, the API generates a custom structure that consists of model data. Then it creates a new block and adds to our blockchain structure. This application is proof of concept so any decentralization operation has not placed here. The following representation shows how to store each data in our blockchain.

```
{
  "data": {
    "client": "1000",
    "threshold": 2.0402233968726113,
    "signatures": { 5 items }
  },
  "prev_hash": "83d7411b8069a6f1ffa6aeee6379f967",
  "timestamp": 1589059782.8318746,
  "proof": 95,
  "index": "2"
}
```

Each block includes block information and client data. Biometrix stores client id, client's threshold and 5 different signature.

```
"signatures": {
  "s1": { 189 items },
  "s2": { 183 items },
  "s3": { 184 items },
  "s4": { 174 items },
  "s5": { 172 items }
}
```

Each signature consists of different number of point and for each point all local features are extracted and normalized.

```
"signatures": {
  "s1": {
    "0": {
      "x": -2.3273184097875808,
      "y": -2.0299110836922662,
      "p": -0.9118306961743208,
      "ax": 0.000985215425370808,
      "ay": 0.045561769486634235,
      "vx": -0.3180134408806965,
      "vy": -0.26205164525698305,
      "altitude": -1.2667917860233886,
      "azimuth": -0.20942373381475807,
      "v": 2.838316634123613,
      "a": -0.8236577815154978,
      "att": -0.035264945396543325,
      "dvp": 0.1661998481278502,
      "alfa": -0.17375871857530167,
      "sina": -0.17375869572902033,
      "cosa": 0.10941281665374704,
      "deva": 0.004580476641988166,
      "devsina": 0.004580476641988166,
      "devcosa": 0.004580476641988166,
      "beta": -0.0454761448571068
    }
  }
},
```

First point of Signature-1.

Transaction

After signing document, user confirms the process. Every confirmed signature defined as transaction. Transaction files are registered on the server. Each transaction file includes several different type of files:

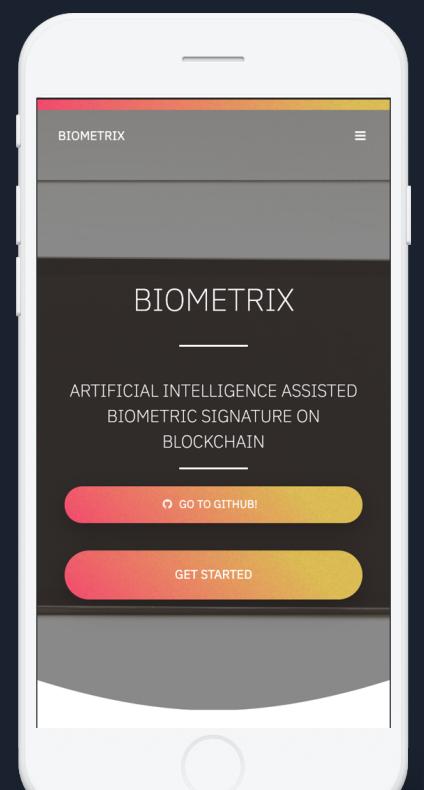
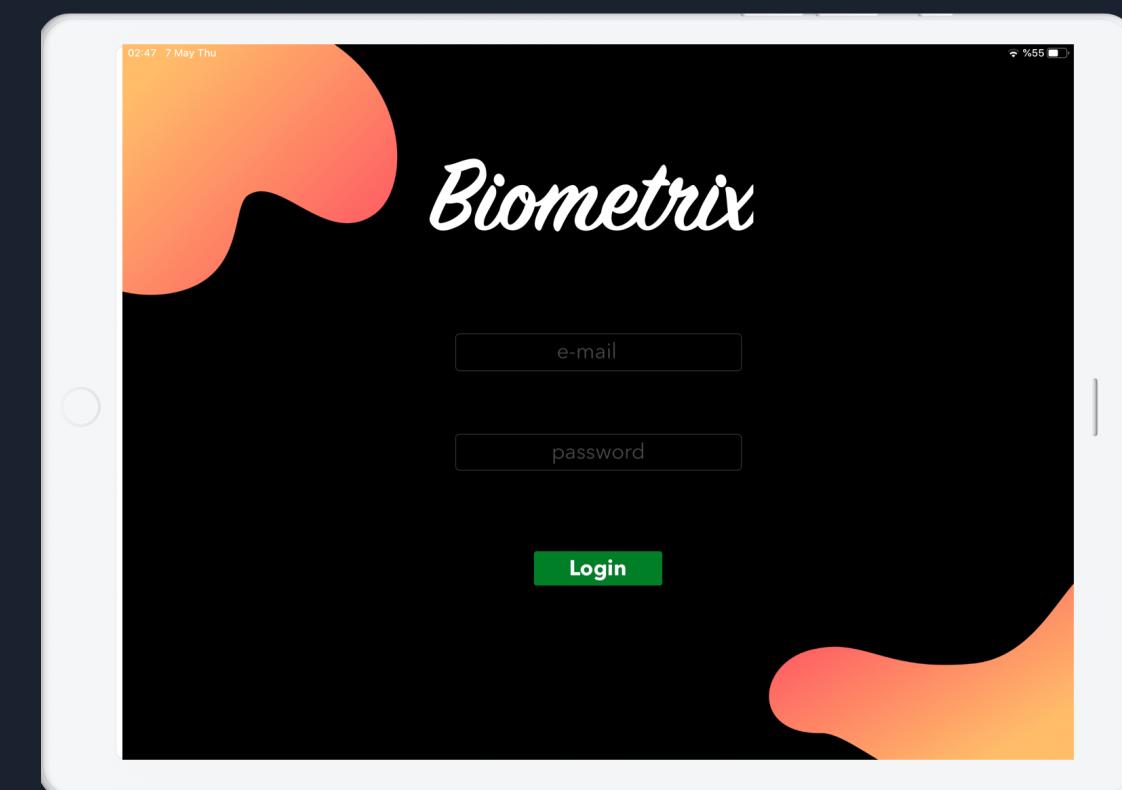
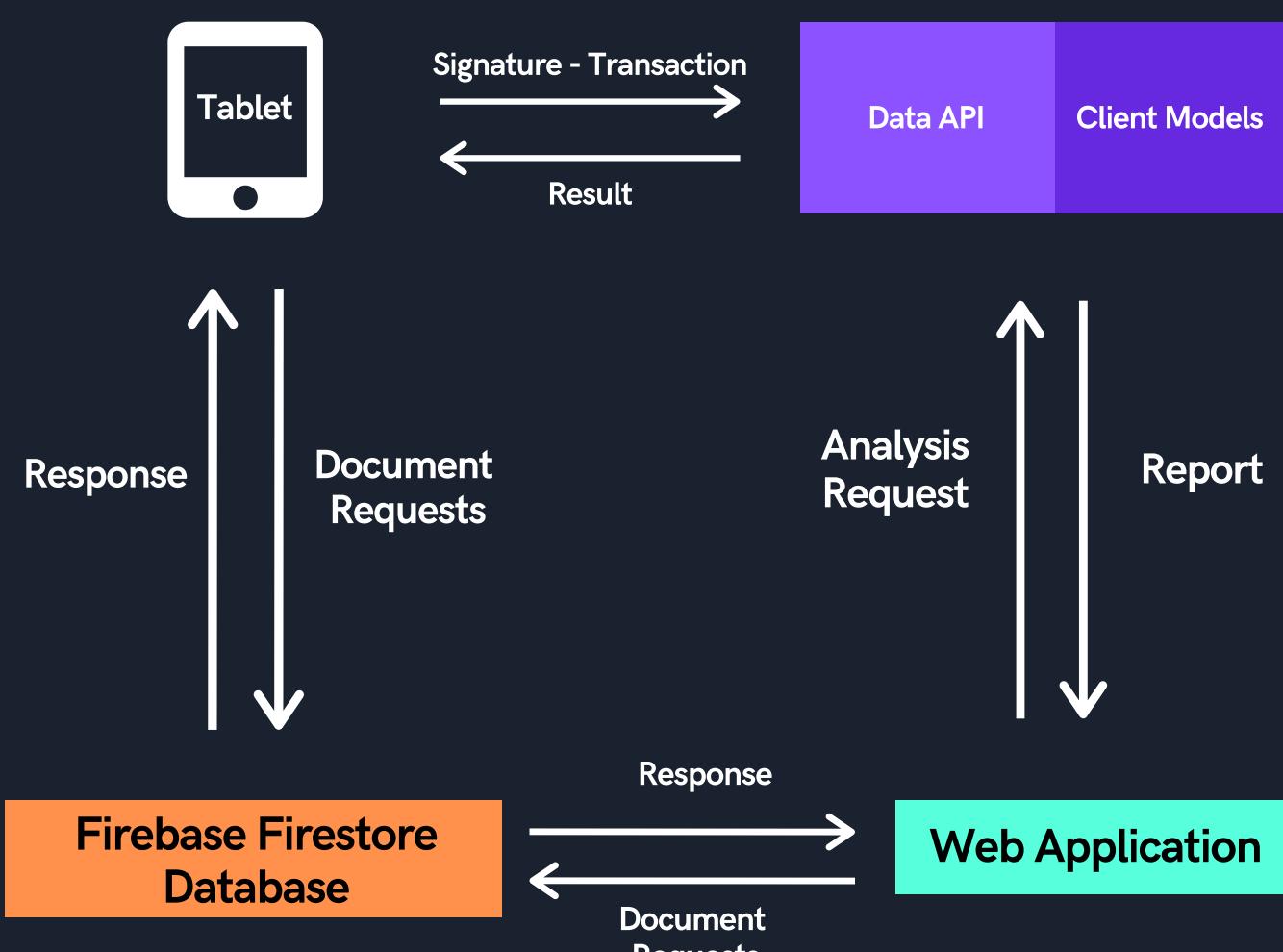
- Detailed information about transaction
- Signature data
- Signature Image
- Signer Image
- Transaction analysis

Each file data captured by the mobile app before transaction confirmed.

```
{
  "transaction-id": "C5E3656C-2099-419E-8A3E-30B15169E99A",
  "client-id": "1000",
  "end-user-id": "taylanakbas@bx.com",
  "document-id": "08517ABE-263C-4694-AC9A-3598C58EF8E0",
  "timestamp": "10-05-2020 01:19:51",
  "signature": { 196 items },
  "score": "2.105936520462211",
  "threshold": "2.040223396872612",
  "difference": "0.066",
  "transaction-result": "Genue",
  "latitude": 38.455412025304646,
  "longitude": 27.185317724649167
}
```

Transaction Detail Example

Project Structure



API

The most important component of the Biometrix environment is the Data-API.

Signature model generation, signature verification, writing the model on blockchain operations runs in the API.

Functionality

REGISTER NEW CLIENT WITH SIGNATURE AND PERSONAL INFORMATION

EXTRACT & COMPARE FUNCTIONS

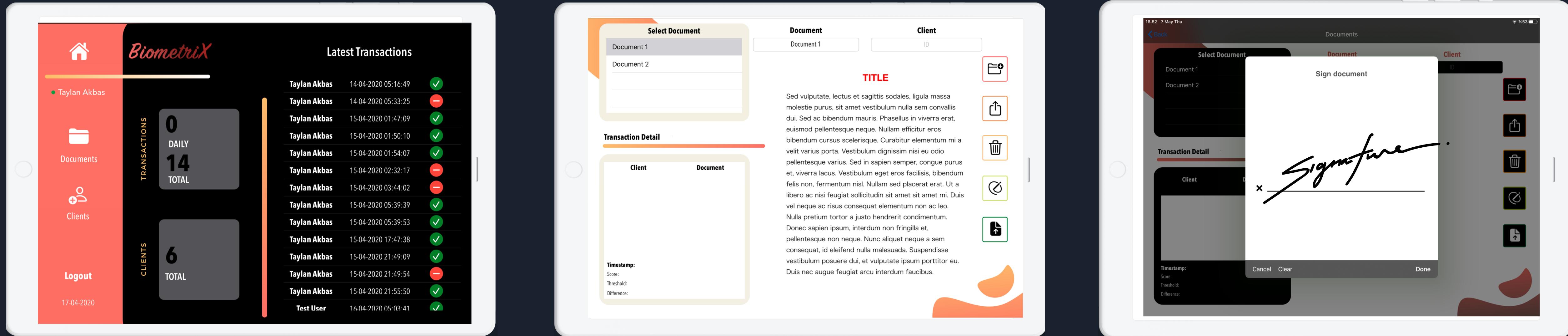
VERIFY CLIENT SIGNATURE USING MODEL

GENERATE TRANSACTION REPORT THAT CONSISTS DETAILED INFORMATION ABOUT VERIFICATION.

CREATE NEW BLOCK FOR BLOCKCHAIN

IMPORT & EXPORT SIGNATURE DATA

Biometrix Client Mobile App



Biometrix Admin Web App

